CLAIMS

What is claimed is:

1. A method for manipulating a nanoscale object comprising:

depositing a plurality of nanoscale objects onto one or more portions of a passive surface of a substrate;

providing a scanning probe microscope having a tip operable to act upon the passive surface;

forming one or more target positions on the passive surface by causing the tip of the scanning probe microscope to act upon one or more portions of the passive surface where a nanoscale object is not deposited;

forming a bond between at least one of the plurality of nanoscale objects and the scanning probe microscope tip;

moving the scanning probe microscope tip with the at least one nanoscale object bonded thereto to one of the target positions;

forming a bond between the nanoscale object and the target position; and

breaking the bond between the scanning probe microscope tip and the nanoscale object.

2. The method of claim 1 wherein the forming one or more target positions by causing the scanning probe microscope tip to act upon one or more portions of the passive surface where a nanoscale object is not deposited comprises at least one of removing a portion of the passive surface and activating a portion of the passive surface.

3. The method of claim 1 wherein the nanoscale object is selected from the group consisting of atoms, molecules, dendrimers, macro-molecules, viruses, phages, colloids, clusters, nanoparticles and nano-devices.

4. The method of claim 1 wherein the plurality of nanoscale objects comprise fullerene molecules.

5. The method of claim 4 wherein the fullerene molecules are C_{60} molecules.

6. The method of claim 1 wherein the scanning probe microscope is selected from the group consisting of: scanning tunneling microscopes (STM); atomic force microscopes (AFM); near-field scanning optical microscopy (NSOM); scanning tunneling optical microscope (STOM); near-field scanning acoustical microscopy (NSAM); scanning capacitance microscope (SCM); and scanning electrochemistry microscope (SECM).

7. The method of claim 1 wherein the passive surface comprises a hydrogen-terminated semiconductor surface.

8. The method of claim 7 wherein the hydrogen-terminated semiconductor surface is a hydrogen-terminated silicon surface.

9. The method of claim 1 wherein the passive surface is selected from the group consisting of a passivated surface, an inherently passive surface and a natively passivated surface.

10. The method of claim 1 further comprising forming the passive surface on the substrate prior to the depositing of the plurality of nanoscale objects.

11. The method of claim 1 wherein the forming of the passive surface comprises dosing the substrate with hydrogen atoms.

12. The method of claim 1 wherein the scanning probe microscope is a scanning tunneling microscope, and the forming one or more target positions on the passive surface comprises utilizing tunneling current from the tip of the scanning tunneling microscope to remove at least one hydrogen atom from the passive surface.

13. The method of claim 1 wherein the forming of the bond between at least one of the plurality of nanoscale objects and the scanning probe microscope tip comprises moving the scanning probe microscope tip toward the plurality of nanoscale objects to cause the forming of the bond between the at least one plurality of nanoscale objects and the scanning probe microscope tip.

14. The method of claim 1 wherein the forming of the bond between the nanoscale object and the target position comprises moving the scanning probe microscope tip to bring the nanoscale object into proximity with the target position sufficient to cause the bond to form between the nanoscale object and the target position.

15. The method of claim 1 further comprising moving the at least one of the plurality of nanoscale objects in a lateral direction on the substrate surface prior to the forming of the bond between the at least one nanoscale object and the scanning probe microscope tip.

16. The method of claim 1 further comprising moving the at least one of the plurality of nanoscale objects in a lateral direction on the substrate surface after the forming of the bond between the at least one nanoscale object and the target position.

17. The method of claim 1 further comprising imaging the substrate surface at least after the forming of the bond between the at least one nanoscale object and the scanning probe microscope tip to confirm formation of the bond between the at least one nanoscale object and the scanning probe microscope tip.

18. The method of claim 1 further comprising imaging the substrate surface at least after the breaking of the bond between the at least one nanoscale object and the scanning probe microscope tip to confirm release of the at least one nanoscale object at the target position.

19. The method of claim 1 further comprising controlling environmental conditions in which the method for manipulating is practiced.

20. The method of claim 19 wherein the controlling of the environmental conditions comprises adjusting at least one of temperature, pH, electric field, magnetic field, vacuum, gas species, and nature of solvents.

21. The method of claim 1 further comprising moving at least one of the plurality of the nanoscale objects in a lateral direction on the substrate surface prior to the forming of the one or more target positions.

22. The method of claim 1 wherein the passive surface lies substantially in a single plane.

23. The method of claim 1 wherein the passive surface lies in more than one plane.

24. A method for manipulating a nanoscale object comprising:

depositing a plurality of reactive nanoscale objects onto one or more portions of a passive surface of a substrate wherein each of the plurality of nanoscale objects has one or more reactive sites covered with a cap;

providing a scanning probe microscope having a tip operable to act upon the passive surface and the cap;

forming a reactive site target position on at least one of the plurality of reactive nanoscale objects by causing the scanning probe microscope tip to remove the cap;

forming a bond between the scanning probe microscope tip and another of the plurality of reactive nanoscale objects;

moving the scanning probe microscope tip with the another reactive nanoscale object bonded thereto to the reactive site target position;

forming a bond between the reactive site target position and the another reactive nanoscale object bonded to the scanning probe microscope tip; and

breaking the bond between the scanning probe microscope tip and the another reactive nanoscale object.

25. The method of claim 24 further comprising, prior to the forming of the bond between the scanning probe microscope tip and another of the plurality of reactive nanoscale objects:

forming one or more surface target positions on the passive surface by causing the tip of the scanning probe microscope to act upon one or more portions of the passive surface where a reactive nanoscale object was not deposited;

forming a bond between at least one of the plurality of reactive nanoscale objects and the scanning probe microscope tip;

moving the scanning probe microscope tip with the at least one reactive nanoscale object bonded thereto to one of the surface target positions;

forming a bond between the reactive nanoscale object and the surface target position; and

breaking the bond between the scanning probe microscope tip and the reactive nanoscale object.

26. The method of claim 24 wherein the forming a reactive site target position on at least one of the plurality of reactive nanoscale objects comprises causing the scanning probe microscope tip to remove the cap on the reactive nanoscale object bonded at the surface target position.

27. A method for manipulating a nanoscale object comprising:

depositing a plurality of nanoscale objects onto one or more portions of a passive surface of a substrate wherein at least one of the nanoscale objects comprises a reactive site covered with a cap;

providing a scanning probe microscope having a tip operable to act upon the passive surface and the cap;

forming one or more surface target positions on the passive surface by causing the tip of the scanning probe microscope to act upon one or more portions of the passive surface where a nanoscale object is not deposited;

forming a bond between the scanning probe microscope tip and at least one selected object from the plurality of nanoscale objects;

moving the scanning probe microscope tip with the at least one selected object bonded thereto to one of the surface target positions;

forming a bond between the at least one selected object and the surface target position; and

breaking the bond between the scanning probe microscope tip and the at least one selected object to leave the at least one selected object bonded at the surface target position.

28. The method of claim 27 wherein the at least one selected object comprises a nanoscale object comprising a reactive site covered with a cap, and comprising:

forming a reactive site target position on the nanoscale object bonded at the surface target position by causing the scanning probe microscope tip to remove the cap;

forming a bond between the scanning probe microscope tip and a second selected object from the plurality of nanoscale objects;

moving the scanning probe microscope tip with the second selected object bonded thereto to the reactive site target position;

forming a bond between the second object and the reactive site target position; and

breaking the bond between the scanning probe microscope tip and the second object.

29. A system for manipulating nanoscale objects comprising:

a passive surface on a substrate;

a scanning probe microscope;

a computer readable medium for storing:

(i) fabrication design parameters comprising information on selected locations on the passive surface where target positions are to be formed for the subsequent placement of nanoscale objects;

(ii) control algorithms operable to control operations of the scanning probe microscope; and

a processing unit operable to read the computer readable medium and operate under the control of the control algorithms and the fabrication design to cause the scanning probe microscope to depassivate sites of the passive surface associated with the target positions.

30. The system of claim 29 wherein the passive surface comprises hydrogen-terminated semiconductor material.

31. The system of claim 30 wherein the hydrogen-terminated semiconductor material comprises hydrogen-terminated silicon.

32. The system of claim 29 wherein the scanning probe microscope has a tip and the control algorithms comprise code for moving the tip of the scanning probe microscope toward the passive surface where at least one of the target positions is to be formed and causing the tip to act upon the passive surface to form the target position.

33. The system of claim 32 wherein the control algorithms further comprise code for moving the tip of the scanning probe microscope into proximity of at least one nanoscale object deposited on the passive surface such that a bond forms between the tip and the at least one nanoscale object.

34. The system of claim 33 wherein the control algorithms further comprise code for positioning the tip of the scanning probe microscope with the nanoscale object bonded

thereto into proximity with the target positions such that a bond forms between the nanoscale object and the target position.

35. The system of claim 29 further comprising a plurality of nanoscale objects deposited on the passive surface.

36. The system of claim 35 wherein the plurality of nanoscale objects are fullerene molecules.

37. The system of claim 36 wherein the fullerene molecules are C_{60} molecules.